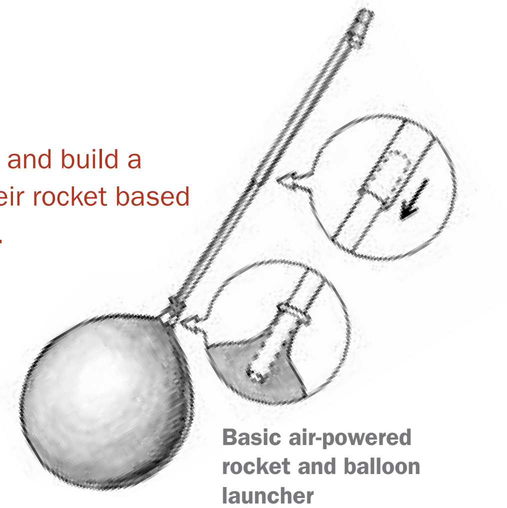
LAUNCH IT

LEADER NOTES

The Challenge

Design and build an air-powered rocket that can hit a distant target.

In this challenge, kids follow the engineering design process to: (1) design and build a rocket from a straw; (2) launch their rocket using a balloon; (3) improve their rocket based on testing results; and (4) try to consistently hit a target with their rockets.



Basic air-powered rocket and balloon launcher

1 Prepare ahead of time

- Read the challenge sheet and leader notes to become familiar with the activity.
- Gather the materials listed on the challenge sheet.
- Build a sample rocket and launcher.

2 Introduce the challenge (10 minutes)

- **Tell kids about the role rockets play in getting people and equipment to the moon.** *To get to the moon, NASA uses a rocket. A rocket is basically a huge engine that lifts things into space. Sometimes rockets carry people (called astronauts) into space. Sometimes, they carry NASA's space shuttle, a satellite, or other piece of space equipment. Today you'll make a rocket out of straw that uses air power to hit a target. By testing your rocket, you'll find ways to make it work better. Improving a design based on testing is called the engineering design process.*

- **Show kids your sample rocket and launcher. See if they can name the main parts.** *The large column that makes up most of the rocket is called the **body**. If you add wing-like sheets to the lower end of the body, they are called **fins**. The small capsule that sits atop the body is the **nosecone**. The nosecone is where the astronauts sit or where NASA stows the satellites or equipment it sends into space.*

3 Brainstorm and design (10 minutes)

Distribute the challenge sheet. Discuss the questions in the Brainstorm and Design section.

- **What are some ways you can change a rocket?** *(Kids can change: the length of the straw; the straw's weight; the weight and shape of the nosecone; the number and position of fins; the amount of air in the balloon; and how they release the air.)*

- **How will adding weight to the straw's nose or having fins affect how it flies?** *(Adding weight to the straw's nose or placing fins near the back can help it fly straighter.)*

- **When you launch your straw rocket, how does the launch angle affect where it lands?** *(Launching a rocket straight up sends it high but not far; straight out makes it fall quickly to the floor. This could be a great opportunity to explore angles with kids.)*

4 Build, test, evaluate, and redesign (30 minutes)

Help kids with any of the following issues. For example, if the straw rocket:

- **sticks to the launch straw**—*The straw might have become wet as kids blew through it. If so, have them wipe it. Also, check that the balloon is inflated enough.*

- **veers off course**—*Add fins, either at the rear or middle of the rocket.*
- **lands on its side instead of nose first**—*Add a little weight to the nose.*
- **doesn't go far**—*Blow up the balloon more; reduce the straw's weight; change the tilt of the launch; change the length of the straw rocket—a longer straw gets a bigger blast of air, which pushes on the straw for a longer time, speeding it up and sending it farther.*

5 Discuss what happened (10 minutes)

Have the kids show each other their rockets and talk about how they solved any problems that came up. Emphasize the key ideas in today's challenge by asking:

- **What features of your design helped your rocket hit the target?** *(Key factors include the rocket's weight, launch angle, ability to fly straight, and the balloon's pressure.)*
- **After testing, what changes did you make to your rocket and launcher?** *(Answers will vary.)*
- **How did changing the launch angle affect how your rocket flew?** *(Steep launch angles send a rocket high into the air but not far horizontally. Shallow launch angles send a rocket far horizontally but not high.)*
- **What's an example of potential (stored) and kinetic (motion) energy?** *(Potential energy: Energy is stored when the balloon is inflated and the material is stretched, and when the rocket is higher in the air. Kinetic energy: Stored energy is changed into motion energy when the pressurized air inside the balloon rushes out and when the rocket moves.)*
- **After reading the stories on the back of the handout, what do you think about traveling by rocket?**

  (Kids see that rockets can travel huge distances, travel fast, and need a lot of force to get going.)

EXTEND THE CHALLENGE

See how far kids' rockets can go.

- Have kids test how far their rocket goes per breath of air used to fill the balloon. For example, have them fill the balloon with three breaths of air, launch the rocket, and measure how far it travels from its launch point. Repeat with five, seven, and nine breaths. Have kids plot distance traveled against number of breaths. (Note: In each round, keep the launch angle constant.)
- Have kids experiment with different launch angles by using a protractor to position a book cover or sheet of cardboard at a series of various angles, such as 30, 45, 60, and 90 degrees. Have them launch their rockets and compare how far they go.

CURRICULUM CONNECTIONS

Launch It ties to the following concepts commonly covered in science, math, and technology curricula. For a list of education standards supported by the activity, see pages 37 and 38.

- **Potential and kinetic energy**—Blowing up a balloon stretches the rubber, which stores energy as potential energy. When the pressurized air inside the balloon rushes out, the potential energy changes to motion energy (kinetic energy), making the rocket move.
- **Distance-angle relationships of an object in flight**—By launching rockets at different angles, kids will see that the travel distance and shape of the flight path change.
- **Path of a moving object**—During flight, the rocket follows a trajectory, which is a curved path.
- **Measurement**—Kids measure launch angles and the distance traveled by the rocket.

A NASA/DESIGN SQUAD CHALLENGE

LAUNCH IT

as built on TV

Going to the moon? You'll need a rocket. The rockets NASA sends to the moon go up to 18,000 miles (29,000 km) per hour. But it still takes about three days to get there. So, sit back, relax, and enjoy the view.

WE CHALLENGE YOU TO...

…design and build an air-powered rocket that can hit a distant target.

BRAINSTORM AND DESIGN

Think about things that might affect how your air-powered rocket flies.

- How long will your rocket be?
- How many paper fins will your straw rocket have—0, 2, or more?
- How will adding weight to the straw's nose or having fins affect how it flies?
- When you launch your straw rocket, how does the launch angle affect where it lands?

MATERIALS (per rocket)

- balloon
- small lump of clay
- paper
- 1 wide straw
- 1 thin straw that fits inside the wide straw
- tape
- target (box lid or paper with a bull's-eye drawn on)
- scissors

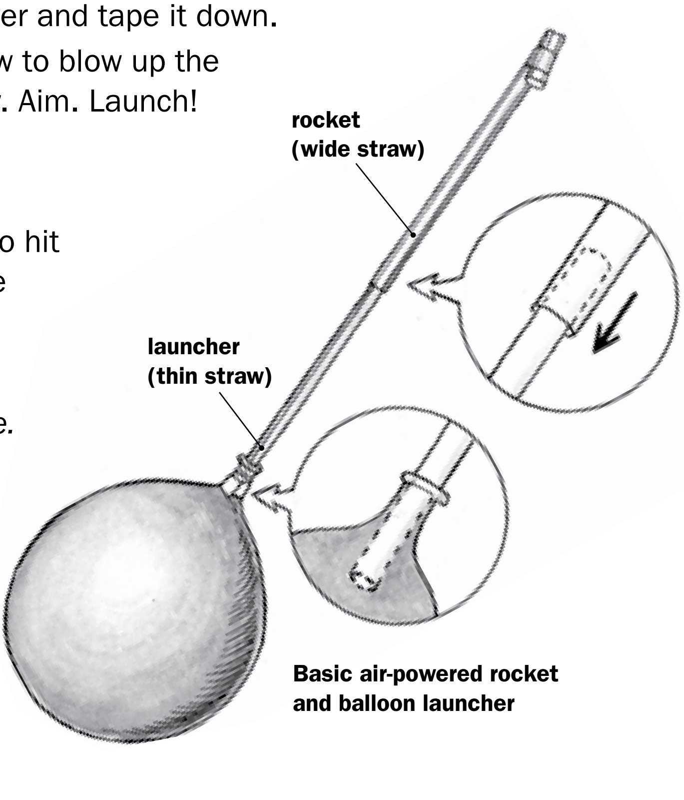
BUILD

1. **First, build a balloon-powered launcher.** Slide 1–2 inches (3–5 cm) of the thin straw into a balloon. Make a tight seal by taping the balloon to the straw.
2. **Next, build a straw rocket.** Use the wide straw for the rocket. Seal one end. Either plug it with clay or fold the tip over and tape it down.
3. **Now launch your rocket.** Blow into the thin straw to blow up the balloon. Slide the wide straw onto the thin straw. Aim. Launch!

TEST, EVALUATE, AND REDESIGN

Set up a target. Stand 5 feet (1.5 m) away and try to hit it with your rocket. Can you make your rocket hit the target every time? Try these things if your rocket:

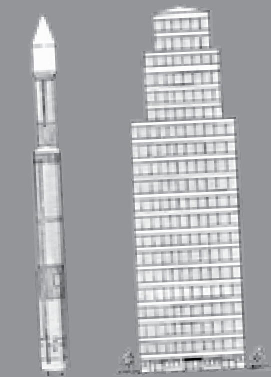
- **falls quickly to the ground**—*Reduce the weight.*
- **misses the target**—*Launch it at a different angle.*
- **won't fly straight**—*See if fins make a difference. Also, try adding weight to the rocket's nose.*
- **sticks to the launch straw**—*Make sure the launch straw is dry. If it isn't, wipe it dry. Also, try blowing up the balloon more.*



Basic air-powered rocket and balloon launcher

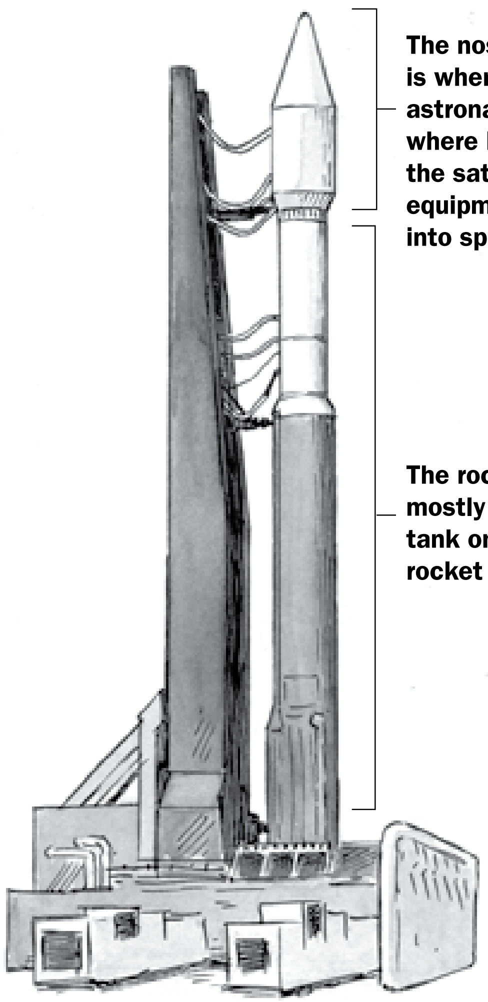
TAKE ME TO THE MOON

It's been over 25 years since NASA's been to the moon. But that's about to change. Soon, two spacecraft—the Lunar Reconnaissance Orbiter and the Lunar Crater Observation and Sensing Satellite—will be on their way. Compared to a rocket, these spacecraft are tiny—together they're the size of a school bus and only about as heavy as a medium-sized elephant. Still, it's not easy to get them into space. The rocket carrying them will burn about 90,000 gallons (341,000 liters) of high-tech fuel in the first few seconds of the trip. When they say, "Blast off," they really mean it.



An Atlas-5 rocket is as tall as a 20-story building.

Check out NASA's moon missions at moon.msfc.nasa.gov.

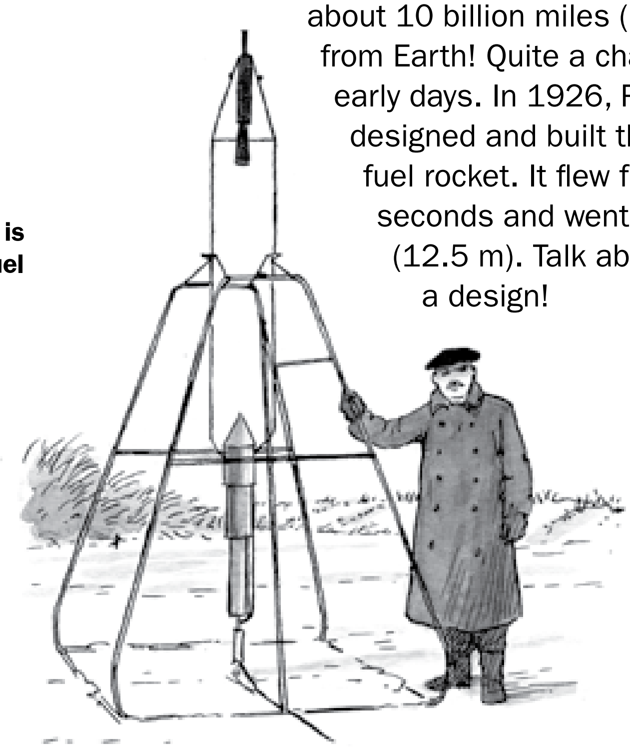


The nosecone is where the astronauts sit or where NASA stows the satellites or equipment it sends into space.

The rocket body is mostly a huge fuel tank on top of rocket engines.

MY, HOW THINGS HAVE CHANGED!

Today's rockets travel fast, far, and for a long time. One rocket, called Voyager 1, has been traveling for more than 30 years and is now about 10 billion miles (16 billion km) from Earth! Quite a change from the early days. In 1926, Robert Goddard designed and built the first liquid-fuel rocket. It flew for only 2½ seconds and went just 41 feet (12.5 m). Talk about improving a design!



Robert Goddard and the first liquid-fuel rocket

Watch DESIGN SQUAD on PBS or online at pbs.org/designsquad.

Major funding for *Design Squad* provided by

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Additional funding for *Design Squad* provided by

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This NASA/*Design Squad* challenge was produced through the support of the National Aeronautics and Space Administration (NASA).

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